SUMMARY OF THE DOCTORAL THESIS

The doctoral dissertation entitled “The Impact of Salinity on the Structural and Functional Diversity of Zoocoenoses and the Ecosystem Health of Lakes” addresses one of the important manifestations of contemporary environmental change in inland aquatic ecosystems—water salinisation. An increase in the concentration of dissolved ions, resulting from climatic, hydrological and anthropogenic influences, may lead to the transformation of habitat conditions, the reorganisation of biotic communities, and a reduced capacity of lakes to sustain ecological processes and provide ecosystem services. The main objective of the dissertation was to explain the effects of climate change, expressed inter alia through salinisation, on the structure of aquatic zoocoenoses and the ecological health of lakes, as well as to assess the usefulness of an integrated ecosystem approach for identifying the mechanisms governing the functioning, resilience and transformation of these systems. The study encompassed 13 lakes differing in geographical location, climatic conditions, salinity level and anthropogenic pressure: nine coastal lakes of the southern Baltic Sea and four lakes in western Kazakhstan. Field material was collected between 2019 and 2021. The analyses included 462 biological samples, comprising 426 macrozoobenthos samples and 36 zooplankton samples, as well as 390 sets of physicochemical data and spatial information concerning 237 geocomplexes and 74 hydrocomplexes. The study applied analyses of taxonomic and functional diversity, Biological Trait Analysis, ordination methods, multivariate tests, beta-diversity analysis, generalized additive models, and multi-criteria ecosystem-health assessment procedures based on the Analytic Hierarchy Process and Fuzzy Comprehensive Evaluation. The results indicate that salinity constituted the principal gradient differentiating the structure of the analysed biotic communities. In the lakes of western Kazakhstan, increasing salinity co-occurred with higher water mineralisation and changes in ionic composition; in zooplankton analyses, it was a more important factor structuring communities than temperature and geographical location. Increasing salinity stress was accompanied by a decline in the species richness of many organism groups, the elimination of stenohaline taxa, and an increasing contribution of eurytopic, opportunistic and ecologically specialised forms. In zooplankton, a particularly pronounced reduction in rotifer species richness was found after exceeding approximately 15 PSU. At the same time, increased salinity did not result in a uniform decrease in all biological indicators: in some lakes, higher organism abundance was recorded concurrently with lower species richness, indicating the dominance of a small number of well-adapted taxa. Macrozoobenthos analyses demonstrated that salinisation changes not only taxonomic composition but also the functional organisation of communities. In lakes with higher mineralisation, mobile, epifaunal organisms tolerant of variable habitat conditions were more important, whereas freshwater and transitional lakes more frequently supported sessile or semi-mobile forms associated with bottom sediments and more stable environmental conditions. This confirms that salinity acts as an environmental filter, leading to shifts in organism life-history strategies, simplification of some ecological niches, and transformation of food-web structure. The study also demonstrated that the ecological health of lakes is not a simple linear function of salinity. The final condition of an ecosystem depends on the interaction between hydrochemical pressures and processes occurring within the catchment and the lake’s immediate surroundings. The integrated Ecosystem Health Index applied in the study included structural integrity, ecosystem process integrity, and the capacity to provide ecosystem services. The most important components of the index were the quality and functioning of buffer zones, catchment land use, total phosphorus concentration, and macrozoobenthos condition. Lakes

under strict protection within Słowiński National Park generally achieved higher and more stable levels of ecological health and ecosystem-service potential than lakes located outside the park boundaries. The findings confirm that salinisation is an important driver of the reorganisation of lake biotic communities; however, its effects are mediated by the landscape and hydrological structure of the surroundings of water bodies. Preserved ecotones, wetlands, forests and semi-natural buffer zones can reduce pollutant inflow, support water and sediment retention, and maintain self-purification processes. The dissertation highlights the need to move beyond lake assessment based exclusively on individual biological or physicochemical indicators. The proposed multi-indicator approach makes it possible to identify ecological thresholds more effectively, diagnose degradation mechanisms, and support integrated lake management under intensifying climate change and anthropogenic pressure.